The USAF Manufacturing Technology

Program Status Report

Air Force Research Laboratory / Materials & Manufacturing Directorate /
Manufacturing Technology Division / Wright-Patterson AFB, Ohio
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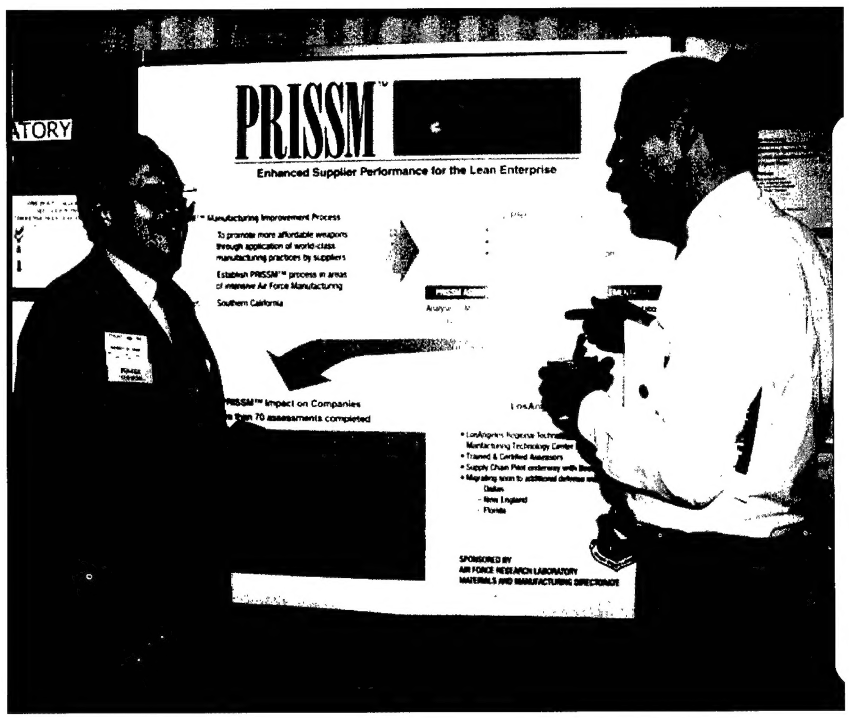
Spring 1999



The Materials and Manufacturing Directorate's Marvin Gale (right) speaks with Harry Stone, of the Institute of Advanced Manufacturing Sciences, at the 1998 Defense Manufacturing Conference. For more on DMC'98, see pages 6-7.

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Air Force
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Science and Technology for Tomorrow's Aerospace Force

Pressure Infiltration Casting May Revolutionize Manufacturing Processes

A manufacturing technology effort supported by the Air Force Research Laboratory (AFRL) Materials and Manufacturing Directorate has resulted in the successful development of a manufacturing process that could help revolutionize and mature metal composite parts fabrication.

The "Advanced Pressure Infiltration Casting Process" (APIC™) developed by Metal Matrix Cast Composites (MMCC), Inc., allows computer-aided-design drawings to be turned into high quality finished products in a matter of days. The process expands rapid prototyping to where new design concepts demanding lightweight, low profile, stiffer materials can be quickly manufactured and evaluated. Durable parts for engines and brakes can be manufactured with a longer life, at just half the weight and at much lower cost. The APIC process has also extended its capabilities to serve the national defense, space and supporting industries such as telecommunication space satellites, aerospace electronic devices and military armor.

The current market demand for developing complex vehicles in less time at reduced costs, with an emphasis on increased performance, high quality and safety, has created major challenges for designers, engineers and manufacturers. One impact has been an increasing trend in the aerospace and defense industries towards reducing the cost of parts manufacturing, even in low production volumes, while producing components that weigh less and are of technically superior quality. The trend is especially noticeable in the composites manufacturing sector, where non-recurring expenses such as prototype design, tooling and production can be very high. Conventional approaches to part development are being replaced with emerging net shape rapid prototyping technologies.

This manufacturing technology effort, supported by the AFRL's Materials and Manufacturing Directorate, working with MMCC, Inc., has led to expanded successful development of MMCC's APIC process which achieves uniform dispersal of particles and incorporates selective tailoring of the part being cast. Unlike conventional casting processes, APIC has the ability to reinforce a multitude of aluminum and copper alloys with many types of materials and architectures, which produce a broad range of choices for designers and engineers.

The process begins with computer-controlled machining of carbon molds. The molds are filled with a ceramic powder consisting of alumina, boron carbide or silicon carbide, and placed into a sealed steel container. Then the container (or casting vessel) is evacuated and molten alloy is transferred to the casting vessel. The can is pressurized in an autoclave, which disperses the alumina particles uniformly throughout the casting. The casting is then cooled and the part extracted and finished. The entire process takes anywhere from several days to a few weeks, depending on complexity and scheduling considerations. Parts produced by this process have an excellent surface and since parts can be cast to near net shape, they require little or no secondary machining. In some

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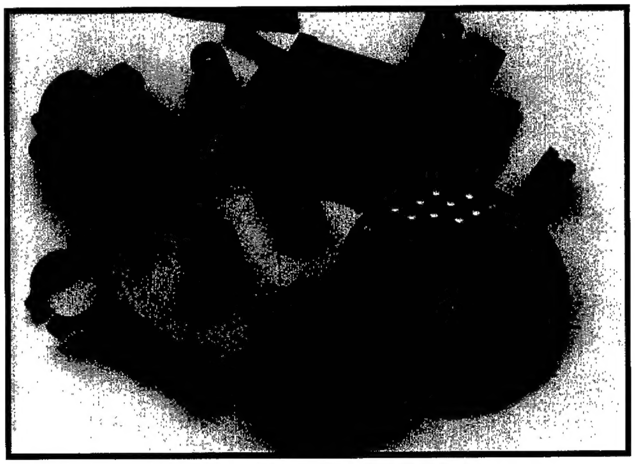
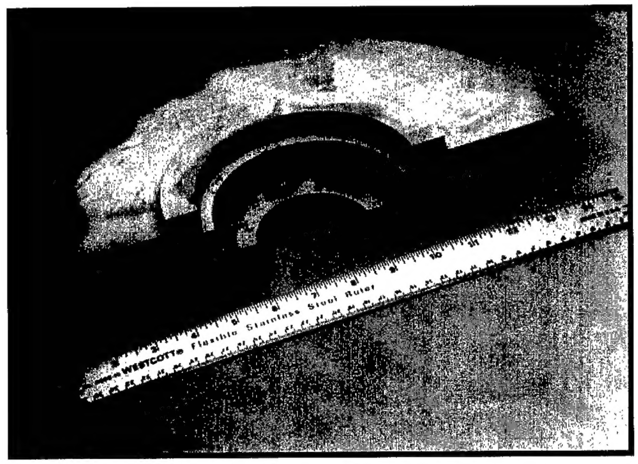
For more information, circle Reader Response Number 1



(Left) Examples of metal matrix composite prototypes



(Right) Liquid cooled brake rotor showing core formed internal structure.

cases, the mold is constructed around a preform, not unlike conventional sand casting.

APIC related research and development is also being supported by the Navy, the Defense Advanced Research Projects Agency (DARPA) and the National Air and Space Administration (NASA). Current and prospective applications include connecting rods for two-stroke outboard marine engines, brake calipers, water-cooled brake discs for heavy trucks working stop-and-go routes and aircraft tow vehicles, brake caliper pistons, brake rotors and circuit board heat sinks. APIC has also been used to fabricate push rods and racing bicycle pedal cranks. APIC-fabricated components are about half the weight of the components they replace, which means they're increasingly useful in the quest for lowered operating costs.

The APIC process offers a highly effective means for developing cost-competitive, metal matrix composite products that can be used to replace steel and other high-density materials. Compared to traditional manufacturing processes, APIC products are only about half the weight, are quick to manufacture, and are cost competitive due to accelerated design and engineering time. The new process allows a CAD-generated component design to be turned into a durable, high quality, finished product faster and at less cost.

Flexible Laser Automated Intelligent Research System Improves Manufacturing and Fabrication Processes

Scientists and engineers at the Air Force Research Laboratory (AFRL) Materials and Manufacturing Directorate and the American Welding Society have developed a Flexible Laser Automated Intelligent Research (FLAIR) System for improving manufacturing and fabrication processes.

The program is attempting to improve global competitiveness in manufacturing for U.S. industry using industrial laser technology, machines, and tooling that can be reconfigured for maximum potential. Continuing development of FLAIR technology may provide significant benefits for national defense through advancements in repairs to turbine engine components and other aircraft parts which previously were scrapped, in particular aircraft and engines with repairable titanium components, saving millions in taxpayer dollars.

As vital military weapon systems designed to protect the nation become increasingly more sophisticated and expensive, it's very important to ensure the highest manufacturing and fabrication standards are established and observed. As a result,

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Department of Defense and commercial production standards are growing more and more dependent on high precision machined parts in order to maintain technological and performance superiority. Unfortunately, the nation's need to provide affordable, precision components in small lots is beyond the capability of today's machine tools. Hence, reconfigurable tooling for metal forming and shaping, precision cutting, grinding, drilling, welding and surface treatment of composites, super alloys, refractory alloys and titanium alloys for fabrication of propulsion and platform systems is the priority.

Flexible tooling for forming, shaping, precision machining and joining of advanced materials will create a vital, new capability in industry to fabricate parts in small lots or in mass production in an assembly line for affordable military and commercial systems. Improved speed, precision and consistency of the tooling system will also provide the basis for affordable ultra fine precision components.

Scientists and engineers at the Air Force Research Laboratory's Materials and Manufacturing Directorate, contracting with the American Welding Society, successfully designed and developed the new FLAIR system to improve key manufacturing and fabrication processes. The program brought together several advanced technologies by providing the research and development to demonstrate advanced laser processing of materials, and focuses on technology development that could lead to major advancements in the ability to repair turbine engine components and other aircraft parts that have in the past been scrapped.

Various laser processing methods were explored for joining, forming and surface treatment of titanium fabricated materials and for the weldability of lead alloys. The knowledge from this program was applied to the repair and surface treatment of titanium turbine blades and production welding of lead-acid battery components. Development of FLAIR technology will provide significant benefits for defense and aerospace products, while offering application as a dual-use technology. The maturity of the technology could greatly affect the industry's ability to process and repair lead and titanium alloys. All Department of Defense aircraft and engines with repairable titanium components will benefit from this technology, which is transferrable to the automotive and aerospace industries.

Continued development of the FLAIR system could improve the nation's global competitiveness through the expanded use of industrial laser technologies and reconfigurable machine and tooling technology.

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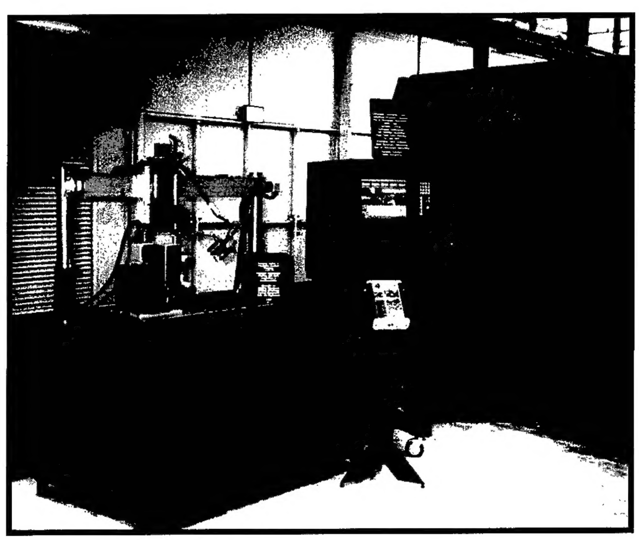

For more information, circle Reader Response Number 2

ABC Makes Manufacturers More Competitive

Engineers at the Air Force Research Laboratory's Materials and Manufacturing Directorate, working with the Industrial Technology Institute, have effectively demonstrated that an activity-based costing (ABC) approach can allow small companies to determine which commercial and military markets they can successfully compete and bid in.

In a traditional manufacturing cost accounting system, overhead costs such as set up, material handling and engineering are accumulated into overhead accounts, then allocated to products based on the amount of direct labor each product requires. This approach worked well a few decades ago when direct labor was a large part of the costs. Today, however, firms that make the significant investment in agile technologies often find themselves less profitable and their market reduced when they fail to consider the impact of these new technologies on their cost structuring.

Activity-based costing (ABC) offers a solution to the problem by assigning job costs based on the actual use of firm resources. ABC is often seen as only a big company solution, and very few small companies have implemented the approach in conjunction with a shift toward agile manufacturing. Engineers at the Air Force Research Laboratory Materials and Manufacturing Directorate, working with the Industrial Technology Institute of Ann Arbor, Michigan, have effectively demonstrated that ABC can allow small companies to determine which commercial and military markets they can successfully compete and bid in while strengthening small business infrastructure.

The central objective of this program was to determine and quantify the costs and benefits associated with using ABC in a small company environment, to support an agile manufacturing strategy. This effort was conducted in five steps. First, six small to medium-sized companies, composed equally of plastic parts processors and machining firms, were selected to serve as study and implementation sites. Next, a conceptual outline of each of the company's cost-flow patterns within an ABC structure was constructed. These served as blueprints for developing a day-to-day cost accounting system that was activity-based and accurately reflected the costs of the products and business unit process. Third, a computer-based cost accumulation model of the company that simulates the activity-based cost flows was constructed. This model provided accurate and relevant product costing rates and served as a tool for calculating incremental costs resulting from potential courses of action. Fourth, "as-is" and "to-be" differences were analyzed in order to determine significant improvements, significant cost increases and other significant changes that could be used to determine the effectiveness of ABC in gathering accurate job costs. Finally, the researchers presented and explained the implementation process to interested companies, through the dissemination of an implementation guidebook and a one-day ABC manufacturing workshop.

All six companies started the project with at least one of their goals being more accurate quoting. By the end of the project, all six became just as interested in the strategic, marketing, and operational information provided by the model, now being used to make capital acquisition decisions, select cost reduction projects and targets, and to make lines of business decisions and operational changes. By assigning job costs based on the actual use of firm resources, the ABC approach facilitates a faster conversion of small companies to ABC implementation and strengthens small business infrastructure considered vital to maintaining a strong defense.

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For more information, circle Reader Response Number 3

1998 Defense Manufacturing Conference Draws People from Government, Industry

More than 930 representatives from the government, academia, and industry gathered in New Orleans, La., recently, for the 1998 Defense Manufacturing Conference.

The Manufacturing Technology Division (ManTech) of the Air Force Research Laboratory Materials and Manufacturing Directorate played a predominate role in the event, which took place Nov. 30 through Dec. 3, at the New Orleans Marriott Hotel. The theme of this year's conference was "ManTech for Affordable Readiness and Modernization".

The Deputy Director for Defense Research and Engineering, Dr. Lance A. Davis, was the Department of Defense keynote speaker for the event, which was hosted by the U.S. Army Material Command. Other general session speakers included Assistant Deputy Chief of Staff for Research, Development and Acquisition, U.S. Army Material Command, Renata F. Price; Deputy Chief of Staff for Research, Development and Acquisition, U.S. Army Material Command, Maj. Gen. John S. Caldwell Jr.; President and CEO, United Defense Limited Partnership, Thomas W. Rabaut; Acting Director of Research Laboratory Management, Office of the Assistant Secretary of the Army, Dr. Robert S. Rohde; Associate Director of Technology, Executive Office of the President, Office of Science and Technology Policy, Dr. Duncan T. Moore; and Deputy Under Secretary of Defense for Acquisition Reform, Stan Z. Soloway.

DMC '98 provided an overview of defense manufacturing, which included detailed discussions related to various manufacturing initiatives, sustainment programs, and current technology thrusts. Perspectives and information about critical DoD manufacturing technology initiatives were exchanged and the status of industry and government programs was presented with a vision for the future of defense manufacturing and industrial modernization.

Approximately 132 government and industry exhibits were on display for the duration of the conference. The ManTech display played a prominent role, highlighting current programs which reduce weapon systems cost and enable advanced performance. Much of the conference centered around technical sessions and mini-symposiums, which addressed metals processing, composites processing, electronics processing, manufacturing and engineering systems, advanced industrial practices, best manufacturing practices, and several special topics.

The ManTech display at DMC '97 was quite prominent.

Associate Director for Manufacturing Technology and Affordability for the AFRL, Timothy L. Dues, moderated a session on Next Generation Sustainment. Several other people from the Directorate were also involved in the conference. Siamack Mazdiyasni helped moderate a session on the Metals Affordability Initiative for Castings and Forgings, and Kevin Spitzer discussed the Forging Supplier Initiative.

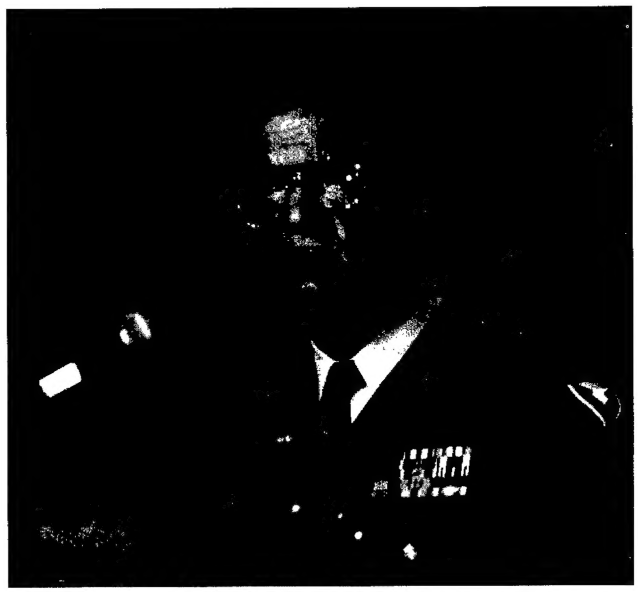
Anthony Bumbalough led a session on Electronics Obsolescence and Sustainment and Bill Russell gave a presentation on Parts Obsolescence Management Tools. Richard Remski helped lead a panel on Manufacturing the New Technology: Hollow State Electronics, and Brench Boden made a presentation on Introduction to the

Advanced Manufacturing Enterprise and discussed the Results of the Air Force ManTech Modular Factory Pilot.

An overview of the Composites Affordability Initiative was given by David Beeler and Pat Price moderated a session on Manufacturing and Engineering Systems. The results and implementation of Military Products from Commercial Lines was briefed by Mary Kinsella, and Laura Leising gave a presentation on Lean Transition of Emerging Industrial Capability.

Robert Reifenberg moderated a session on Lean Aerospace Initiative: Creating Tomorrow's Lean Enterprise Today, in which John Cantrell gave a Lean Overview, Brian Townsend discussed Mapping the Aerospace Value Stream, and Wallace Patterson spoke on Lean Regional Supplier Workshops. Ken Ronald participated in a poster session on Military Products Using Best Commercial/Military Practices.

Deputy Assistant Secretary of the Air Force (Science, Technology and Engineering) Dr. Helmut Hellwig participated in a program managers panel on The Role of New Technology in Weapon System Acquisition. Participating on a DoD Service Acquisition Executive Panel were: Assistant Secretary of the Army (Research, Development and Acquisition) Honorable Paul J. Hoeper; Chief of Naval Research, Rear Admiral Paul G. Gaffney, II; Commander of Defense Contract Management Command, Maj. Gen. Timothy P. Malishenko; and Deputy Assistant Secretary of the Air Force for Management Policy and Program Integration, Blaise J. Durante.



DMC '98 attendees included (from top to bottom) Assistant Deputy Chief of Staff for Research, Development and Acquisition, U.S. Army Material Command, Renata F. Price; Deputy Chief of Staff for Research, Development and Acquisition, U.S. Army Material Command, Maj. Gen. John S. Caldwell Jr.; and Commander of Defense Contract Management Command, Maj. Gen. Timothy P. Malishenko.

Lean Aerospace Initiative Could Significantly Improve Manufacturing Processes

A collaborative research effort involving engineers at the Air Force Research Laboratory (AFRL) Materials and Manufacturing Directorate, other federal government agencies, aerospace industry, labor and academia could dramatically improve defense manufacturing processes over the next 30 years.

The Lean Aerospace Initiative provides industry with a clearer understanding of the principles, priorities and data required to define important areas of enabling research and development, and to share experiences and knowledge. Widespread application could sharply lower aerospace production costs, significantly shorten development and production cycle times, improve product quality and minimize waste.

During past business draw downs, the tendency has been to simply shrink in place while awaiting the next surge in defense spending. The Lean Aerospace Initiative (LAI) was developed and initiated out of necessity as declining defense procurement budgets collided with military industrial over-capacity, resulting in a demand for less expensive, faster produced and higher quality products. The term "lean" represents a fundamentally different approach for managing and organizing enterprises. The main objective of LAI is to develop a framework for implementation of enterprise-wide lean principles and practices that better support the nation's military aircraft needs over the next three decades.

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For more information, circle Reader Response Number 4

LAI traces its origins to the International Motor Vehicle Program (IMVP) conducted by the Massachusetts Institute of Technology (MIT) and described in the book, "The Machine that Changed the World." The IMVP was able to use a single manufacturer, Toyota, as a benchmark for lean implementation within the auto industry. With IMVP research acting as a catalyst, the U.S. auto industry responded by re-engineering management, design and manufacturing processes to become more competitive in the global market.

The LAI was launched in 1993 when leaders from the Air Force and other government agencies, defense aerospace businesses, organized labor and academia formed a partnership to revolutionize the aerospace industry, reinvigorate the workplace and reinvest in America. Dramatically reduced product cycle times, significant cost reductions and improved quality are now progressively being achieved through LAI, which is serving as a unique platform for linking all the stakeholders, providing a forum for interchange, and developing a growing database of practices and supporting information. LAI has substantially lowered costs and achieved shorter cycle times and significant quality improvements by re-engineering organizations and key processes. This includes all aspects of the product realization process, starting with Integrated Product/Process Development (IP/PD); focusing on improvements in product quality, waste minimization and response time; building strong supplier relationships through partnering and teaming; and using less of everything including design time, inventory, buffers, management layers, capital, cycle time and suppliers.

The AFRL Materials and Manufacturing Directorate initiated an assessment with MIT and

private industry on the applicability of "lean production" to the military aircraft industry, concluding that lean principles do apply and significant benefits are possible if lean practices are adopted. Senior leadership endorsed the initiative and to date, MIT has authored more than 80 publications as a result of LAI surveys, case studies and site visits. These publications served as a basis for the Lean Enterprise Model (LEM) which acts as the primary means of transitioning the results of LAI research into real application. The LEM provides a framework for identifying and evaluating lean practices and metrics in such a way that consortium members can understand the relative lean status changes. The development of the LEM has focused on definition of a hierarchical information structure and the selection of automated media for dissemination of the results. LAI is providing leadership with a common understanding of the principles, priorities and data required and a collaborative environment needed to measure progress, share experiences and knowledge, and define areas of enabling research and development.

Lean Aerospace Initiative concepts are providing the nation's aerospace industry an opportunity to address the challenges posed by steep reductions in DoD procurement and worldwide competition. Adoption of LAI principles and practices will allow the aerospace industry to meet customer requirements for affordability and responsiveness without sacrificing performance. Through LAI, industry's position as the world's leading producer of advanced technology aircraft systems will be significantly strengthened.

New AWACS Synchronizer Improves Component Reliability and Availability

A manufacturing technology effort supported by Air Force Research Laboratory (AFRL) Materials and Manufacturing Directorate, working with Northrup Grumman, has led to the development and testing of a synchronizer subsystem that dramatically enhances parts obsolescence abatement on the Airborne Warning and Control System (AWACS) radar.

The synchronizer uses the Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL) to improve component reliability and availability by reducing CCAs (circuit card assemblies) from 19 plus spares to only one CCA plus one spare per aircraft. Upgrading all 33 AWACS aircraft with the synchronizer will increase mission availability, reduce maintenance downtime, lower repair and parts acquisition costs, and result in a net savings to the Air Force of more than $18 million.

Parts obsolescence management approaches focusing on component for component replacement have worked well in some cases but not for critical electronics subsystems such as the AWACS synchronizer, a highly sophisticated subsystem used to align the signals transmitted from the aircraft's radar system. In this case, the obsolescence is so widespread, continued redesign efforts on a component-by-component basis are no longer considered cost effective.

The synchronizer is a two-level card-cage resident in the radar's analog cabinet and is comprised of 19 circuit card assemblies (CCAs) plus spares. Eighteen CCAs are unique to AWACS and 17 have a very high count of diminished manufacturing source (DMS) components, making them unsupportable or non-repairable. Compounding these problems is the fact that most of the computer hardware incorporated into the AWACS Synchronizer uses emitter-coupled logic (ECL) components no longer available. Consequently, a more practical and economically sound approach to parts obsolescence abatement is form, fit, function and interface (F^3I) replacement

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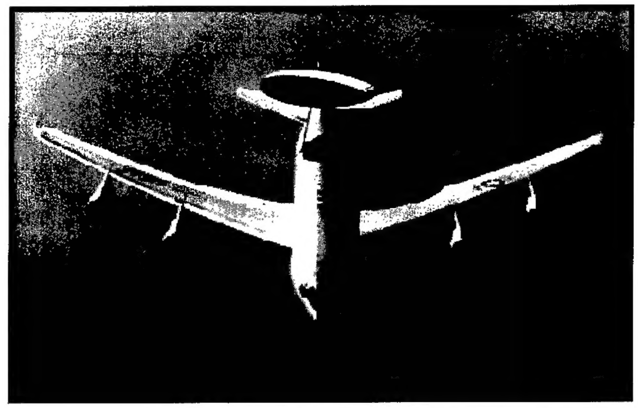
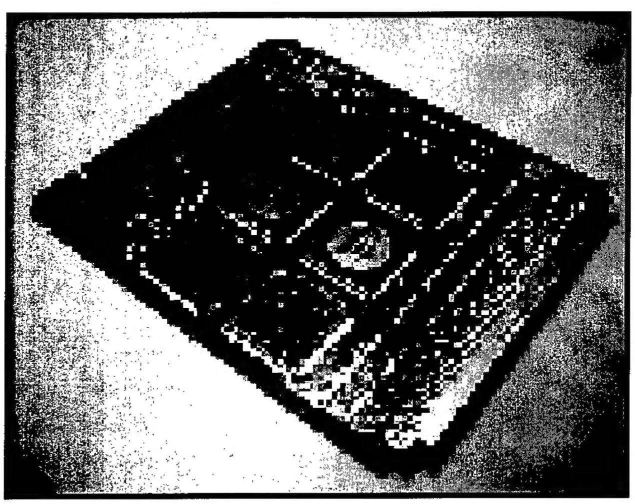
at the subsystem level of integration.

Engineers at Northrup Grumman, under support from the AFRL Materials and Manufacturing Directorate, have successfully designed, developed and completed the initial testing of an AWACS Synchronizer that dramatically enhances parts obsolescence management while improving component reliability and availability. The new subsystem is represented by VHDL F3I simulation models. VHDL lends itself very well to the Synchronizer design at this time because it is all digital (i.e. no analog) and any future AWACS enhancements will need a Synchronizer subsystem much like this one. Hence, the latest VHDL model of the hardware can be used as a synthesizeable simulation model for future synchronizers.

If a CCA fails and cannot be repaired (and no spares are available) it can be replaced along with other CCAs at one time with one VHDL design in the latest hardware technologies available at the time. For approximately the same cost of replacing the single failed CCA, a replacement CCA containing the functionality of a whole group of CCAs can be inserted into the system. For procurement of a new system, the smaller number of assemblies from the outset would constitute a major cost savings. In the case of the AWACS Synchronizer, the net savings to the Air Force (and the taxpayer) is estimated at $18.76 million. In addition, the new system will have a much higher reliability than the subsystem currently in use on the aircraft.



The AWACS aircraft and the new VHDL Synchronizer



Upgrading AWACS aircraft with the new synchronizer will increase mission availability, significantly reduce maintenance downtime, and lower repair and parts acquisition costs. Lessons learned from implementing this new technology on the AWACS radar system could flow into further implementation on other defense systems. This proof of concept initiative will serve as an excellent model for approaching electronic parts obsolescence from a form, fit, function and interface (F^3I) perspective.

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For more information, circle Reader Response Number 5

Materials & Manufacturing Directorate Combines Roadmap Review, SBIR Days

Leaders from industry, government and academia will gather at the Dayton Convention Center the week of July 19, to participate in what has in the past been two annual Air Force Research Laboratory Materials and Manufacturing Directorate (ML) events.

This year, the Directorate has integrated its annual Roadmap Review and Small Business Innovation Research (SBIR) Industry Days so that attendees can participate in both events, without having to make two trips to Dayton. The consolidation will also prove cost effective, taking advantage of similar requirements for these activities.

The theme for the 1999 Roadmap Review/ SBIR Industry Days is, "Moving Materials, Processes, and Manufacturing Technologies into Space and the 21st Century." Insight into planned Air Force materials and manufacturing research and development activities will be provided, along with an opportunity for participants to offer suggestions and ideas on future directorate research and development efforts. Each day of the review features breakout workshops offering participants an opportunity to learn more about specific technology areas being pursued by ML researchers.

An overview of the Directorate's mission of helping industry maintain an affordable defense materials and manufacturing capability will be given. Directorate engineers discuss program accomplishments, present planning activities and future new starts, and provide direction and guidance to the defense materials and manufacturing community.

The event will also will allow researchers to present topics for aerospace materials research and development that require innovative solutions. Each year, the Air Force identifies a number of problem areas in aerospace research and development that require increased emphasis. Through the SBIR program, small businesses compete for research dollars to help solve these problems. Facts and strategies learned at this meeting will help attending companies submit stronger, more competitive SBIR proposals, which in turn will provide the Air Force with cost-effective technical and scientific solutions to challenging problems.

Last year's Roadmap Review drew more than 400 people, and 150 people attended the 1998 SBIR Industry Days. Event organizers are hoping the new integrated format will encourage an even larger turnout this year, and will provide a good opportunity for small and large businesses to foster working relationships.

For more information on the 1999 Roadmap Review/SBIR Industry Days event, contact the Universal Technology Corporation, (937) 426-2808. To learn more about the Materials and Manufacturing Directorate, visit their website at: www.afrl.af.mil

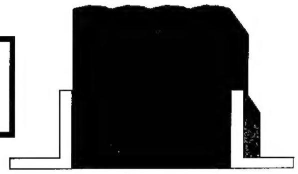
END OF CONTRACT FORECAST

DATE	PROJECT TITLE CONTRACT NO.	PRIME CONTRACTOR	POINT OF CONTACT
March 1999	Simulation-Based Design System for Multi-Stage Manufacturing Processing F33615-98-C-5162	Modern Computational Technologies Inc Cincinnati, OH	Garth Frazier (937) 255-8786
March 1999	Simulation-Based Design System for Multi-Stage Manufacturing Processes F33615-98-C-5161	Technirep Incorporated Eaton, OH	James Malas (937) 255-8786
March 1999	Development of Affordable Optic Chips F33615-97-C-5124	Ramar Corporation Northborough, MA	Ronald Bing (937) 255-2461
March 1999	Electronics CAD-CAM Exchange (ECCE) F33615-96-C-5118	Intermetrics Incorporated McLean, VA	William Russell (937) 255-7371
March 1999	Collaborative Optimization Environment F33615-96-C-5613	Engineous Software Incorporated Morrisville, NC	Brian Stucke (937) 255-7371
March 1999	Multiphase Integrated Engineering Design (MIND) F33615-96-C-5621	University of Utah Salt Lake City, UT	Theodore Finnessy (937) 255-4623
March 1999	Supply Chain Integrated Product/Process Development (IPPD) Pilot Project (SCIP) F33615-96-2-5602	Automotive Industry Action Group Southfield, MI	George Orzel (937) 255-4623
April 1999	Simulation-Based Design System for Multi-Stage Manufacturing Process F33615-98-C-5163	Deformation Control Technology Incorporated Cleveland, OH	James Malas (937) 255-8786
April 1999	Metal Forming Simulation for Stretch-Forming Process F33615-98-C-5120	Northrop Grumman Corporation El Segundo, CA	Deborah Kennedy (937) 255-3612
April 1999	Identification & Quantification of Structural Damage (Structural Repair of Aging Aircraft) F33615-97-2-5151	Northrop Grumman Corporation El Segundo, CA	Michael Waddell (937) 255-7277
April 1999	Dynamic Polymer Composite (DPC) Connectors for Affordable Composite Structures F33615-97-C-5126	The Technology Partnership Grosse Isle, MI	Vincent Johnson (937) 255-7277
April 1999	Flexible Environment for Conceptual Design F33615-96-C-5617	Rockwell International Corporation Palo Alto, CA	Daniel Lewallen (937) 255-7371
April 1999	Built-In Test of Known Good Die F33615-96-1-5610	Rutgers State University Piscataway, NJ	William Russell (937) 255-7371
April 1999	High Purity Float Zone (HPFZ) Silicon F33733-93-C-1014	Unisil Corporation Mountain View, CA	John Blevins (937) 255-3701
April 1999	Fast and Flexible Communication of Engineering Information in the Aerospace Industry F33615-94-C-4429	Massachusetts Institute of Technology Cambridge, MA	George Orzel (937) 255-4623

End of Contract Forecast

DATE	PROJECT TITLE CONTRACT NO.	PRIME CONTRACTOR	POINT OF CONTACT
May 1999	Automated Data Acquisition for In-Situ Material Process Modeling F33615-97-C-5841	Infoscribe Technologies LTD Beavercreek, OH	David Conrad (937) 255-8786
May 1999	Rapid Design and Analysis of Advanced Manufacturing Systems Numerous	University of Toledo Toledo, OH	David Judson (937) 255-7371
May 1999	Internal Real-Time Distributed Object Management System F33615-96-C-5112	Systran Corporation Dayton, OH	David Judson (937) 255-7371
June 1999	Conformable Multichip Assembly Technology F33615-98-C-5149	Epic Technologies Incorporated Woburn, MA	Charles Wagner (937) 255-2461
June 1999	Lead Time Reduction F33615-96-2-5620	Lockheed Martin Corporation Marietta, GA	Brench Boden (937) 255-4623
June 1999	Lean Blade Repair Pilot F33615-93-C-4301	General Atomics Corporation San Diego, CA	Rafael Reed (937) 255-2413
July 1999	Reproducible F119 Turbine Exhaust Case (TEC) Castings F33615-98-C-5160	United Technologies Corporation Pratt & Whitney West Palm Beach, FL	Rafael Reed (937) 255-2413
July 1999	Net Shape Casting Production Machine F33615-97-C-5123	Metal Matrix Cast Components Incorporated Waltham, MA	David Judson (937) 255-7371
July 1999	Labor Infrastructure for Agile High Performance (AHP) Transformations F33615-95-C-5512	Work & Technology Institute Washington, DC	Paul Bentley (937) 255-7371
August 1999	Optimal Design of Bulk Forming Processes Numerous	Rensselaer Polytechnic Institute Troy, NY	David Judson (937) 255-7371
August 1999	Supply Chain Management for Electronics Manufacturing with Product Recovery and Remanufacturing Numerous	Purdue University West Lafayette, IN	David Judson (937) 255-7371
August 1999	A Distributed Decision Framework Integrating Manufacturing Planning and Supply Chain Management Numerous	Lehigh University Bethlehem, PA	David Judson (937) 255-7371
August 1999	Oregon International Internship Program F33615-95-2-5552	Oregon State University Corvallis, OR	Patrick Price (937) 255-4623
August 1999	Design and Manufacture of Low Cost Composites (DMlCC), Bonded Wing F33615-91-C-5729	Textron Corporation, Bell Helicopter Fort Worth, TX	Vincent Johnson (937) 255-7277

Reports



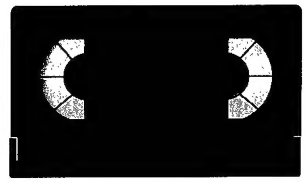
Static and Accessory Repair/Advanced Repair for Static Components (Robotic Engine Manifold Cleaning Cell)
Alog Number: 4151
Contract Number: F33615-87-C-5271
Technical Report Number: WL-TR-95-8029
Distribution: LIMITED

Electrophotographic Patterning for Large Area Electronics
Alog Number: 4162
Contract Number: F33615-94-1-4448
Technical Report Number:
ML-WP-TR-1998-4417
Distribution: LIMITED

Engine Supplier Base Initiative
Alog Number: 4164
Contract Number: F33615-95-2-5555
Technical Report Number:
TR-WP-TR-1998-4122
Distribution: LIMITED

Frequency Conversion Material Producibility
Alog Number: 4166
Contract Number: F33615-93-C-4300
Technical Report Number: WL-TR-97-8031
Distribution: LIMITED

Low Cost Flat Panel Display Fabrication
Alog Numbers: 4167
Contract Number: F33615-94-1-4448
Technical Report Number:
WL-TR-1998-4117
Distribution: UNLIMITED



Videos

Retirement for Cause
Alog Number: 119
Length: 1:00:00
Distribution: LIMITED

Physical Data Network
Alog Number: 120
Length: 50:00
Distribution: LIMITED

Model 1500 CT System for ARNIS
Alog Number: 121
Length: 12:35
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Spring 1999

The USAF Manufacturing Technology

PROGRAM STATUS REPORT

Spring 1999

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